NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3550 MIDTERM EXAM II 11/92 Po

- This exam is open book and notes.
- There are three problems; each is equally weighted.
- Partial credit will be given; be sure to do some work on each problem.
- Be *sure* to include units in your answers.
- Please circle or underline your answers.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.

1	
2	
3	
Total	

Name: _____

1. An surface–emitting LED couples 2 μW of power into a 62.5/125 graded–index optical fiber ($n_1 = 1.48$, $g = 1.8$). The LED is a Lambertian emitter that emits a total power of 100 μW from an active spot that is 50 μm in diameter.

   Find n_2 of the fiber.

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2. A germanium APD receiver has the operating specifications given below. It is used to detect an optical signal with a power of 10 nW at a wavelength of 1330 nm.

Ge APD	
Parameter	Value
$\mathcal{R}_0$ (A/W)	0.5
$F(M)$	$M^{1.0}$
$I_{\text{dark bulk}}$ (nA)	1.0
$I_{\text{dark surf}}$ (nA)	0

Preamplifier	
Parameter	Value
Noise figure (dB)	4
Noise bandwidth (MHz)	60
Voltage gain (V/V)	20

Load Resistor	
Resistance (kΩ)	100
Noise temperature (K)	600

   (a) Find the optimum value of M.

   (b) Find the signal–to–noise ratio *(in dB)* for a value of M that is one-half of the optimum value.

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3. As the designer of an optical–fiber link receiver, you are given a choice from three different silicon MOSFETs with the specifications of the table below.

Parameter	FET #1	FET #2	FET #3
g_m (mS)	20.0	30.0	40.0
C_{gs} (pF)	1.00	0.75	0.50
C_{gd} (pF)	0.050	0.10	0.75
Γ	1.5	3.0	1.8
I_{gate} (nA)	0	0	0
f_c (MHz)	30.0	8.0	4.0

The chosen FET is to be used in integrating front–end preamp for a silicon *pin* diode detector. This detector has a receiving area that is 150 μm in diameter and depletion-region height that is 12 μm (including the height of the intrinsic material layer). (The permittivity of silicon is $\epsilon = 1.036 \times 10^{-10}$ farads/meter.) The parasitic capacitance of the receiver is $C_s = 0.1$ pF. The detector operates into a load resistor of 100 kΩ that has a noise temperature of 400 K.

The receiver is to work in a fiber link that operates at 1 Gb/s at a wavelength of 830 nm.

(a) Which FET should you choose? (Justify your choice.)

(b) For your chosen FET, calculate the value of the mean–square noise current of the amplifier for RZ coding.